The Role of Positive Distraction in the Patient's Experience in Healthcare Setting: A Literature Review of the Impacts of Representation of Nature, Sound, Visual Art, and Light

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The Role of Positive Distraction in the Patient's Experience in Healthcare Setting: A Literature Review of the Impacts of Representation of Nature, Sound, Visual Art, and Light

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SUMMARY

Background

One of the key strategies to help patients reduce stress and anxiety in healthcare settings is positive distraction defined as “an environmental feature that elicits positive feelings and holds attention without taxing or stressing the individual, thereby blocking worrisome thoughts” (Ulrich, 1991, p. 102). While several studies found the impact of positive distraction on health-related outcomes, few studies have categorized the distractors and collected the evidence from experiments. Despite the common use in design and broadly accepted assumption that positive distraction brings psychophysiological benefits, there has not been a comprehensive evaluation of research on positive distraction.

Methods

The present literature review examined 40 peer-reviewed articles from the last 20 years on nature, artwork, music, and light to describe the phenomenon of positive distraction, review the evidence on the impact of interventions on outcomes, and investigate the quality of the research. This paper explored historic background, definitions, and organized the key information from articles into a table. Based on the similarities of themes, I categorized and described the interventions. This paper presents a framework that links the categories to healthcare settings, outcomes, and measures which were used to assess each outcome. Finally, I marked the number of studies in each category that indicated the beneficial influence of interventions for each outcome. The significance of this study lies in collecting and analyzing the studies, describing the crucial aspects that need to be considered when designing positive distractions, and pointing out the directions for future research.

Results

I organized interventions into the following seven categories: Real and artificial nature, Visual representation of nature, Music and Sound, Light, Illuminated projection, Audiovisual, and Audiovisual with light. The most common interventions were plants placed in a patient room as

well as Illuminated projection and Audiovisual interventions with light in diagnostic imaging rooms. Pain and anxiety were the most studied outcomes. While 16 out of 22 studies found a statistically significant improvement in perceived pain, only 10 out of 24 articles found this effect for anxiety. More than 60% of studies that measured the impact of interventions on pain, satisfaction, environmental satisfaction, reduction in restlessness and calm behavior, and perceived attractiveness found statistically significant positive results. Although the positive distraction was initially recognized for its potential to reduce stress, only eight articles investigated stress and distress, but more than half of those studies found a beneficial effect. Interventions in Real and Artificial Nature, and Music and Sound, and Audiovisual with Light showed a beneficial impact on more than six outcomes and emerged as the most promising.

Conclusions

Despite the 40-years tradition, the field of positive distraction is still in an exploratory phase. This analysis confirmed that there is a positive correlation between positive distraction and outcomes and strong evidence that positive distraction helps reduce perceived pain. Future work should consider the division of the term positive distraction into more precise sub-terms to account for different characteristics of interventions categorized as a positive distraction as well as focus on defining the beneficial features of the distractors, explaining the underlying mechanisms, determining the effect size of interventions, and improving both aesthetics of interventions and the methodological quality of studies.

INTRODUCTION

Staying in a hospital is undoubtedly a stressful experience for patients. One of the key strategies to help patients reduce stress and anxiety in healthcare facilities is a positive distraction. A positive distraction is an appealing ambient quality that has a beneficial impact on the psychophysiological state of the individual. The topic has been studied for almost 40 years in the context of Evidence-Based Design and researchers have reckoned that positive distraction alleviates pain and reduces perceived stress (Shepley, 2006). However, despite the common use in design and broadly accepted assumption that positive distraction brings psychophysiological benefits, there has not been a comprehensive evaluation of research on positive distraction.

The concept of positive distraction derives from the cognitive coping strategies for pain, among which we can differentiate imagery and attention-diversion techniques as ways to attenuate pain (Fernandez, 1986). While there is an opportunity for architecture and Evidence-Based Design to create a soothing environment by providing a positive distraction, most of the interventions draw from the tradition of music therapy and horticultural therapy. For this reason, early work in the field of positive distraction focused on exposing participants to color slides with the views of nature. Researchers found that the views of water and vegetation held the attention and interest of the participants to a greater extent and in a more effective way than the presented urban scenes (Ulrich, 1981). The attention-holding properties explored in this research would later form the basis of the concept of positive distraction. Later, the color slides were replaced with window outlooks in the hospital rooms. Subsequent work investigated the recovery process of matched patients after cholecystectomy assigned to a room with a window view of a natural setting versus patients assigned to a room facing a brick building wall (Ulrich, 1984). This notable work showed that patients staying in the room with the nature vista had shorter hospital stays and requested fewer analgesics (Ulrich, 1984). Although these results were initially thought to corroborate the theory of the restorative influence of nature view, they

were later debated by research on the impact of daylight on the length of hospital stay (Park, Chai, Lee, Moon, & Noh, 2018) and postoperative analgesic medication use (Walch et al., 2005). While Ulrich found an empirical link between the nature view and the use of analgesics, there was no clear explanation of these findings. Therefore, views of nature, daylight, and other elements should be further investigated as factors playing a crucial role in shortening the recovery process. Eventually, Ulrich created the Theory of Supportive Design and named three factors that help overcome stress and improve well-being: an increased sense of control and privacy, social support, and access to positive distraction (1991). In this work, Roger Ulrich first coined the term *positive distraction* and provided the following definition, which is the most widely cited explanation of this term in the literature: "an environmental feature that elicits positive feelings and holds attention without taxing or stressing the individual, thereby blocking worrisome thoughts" (Ulrich, 1991, p. 102). The main role of positive distraction is to mitigate stress (Shepley, 2006), which is caused by two principal factors: illnesses and physical and social environments (Ulrich, 1991). The term distraction denotes "the direction of attention to a non-noxious event or stimulus in the immediate environment" (Fernandez, 1986). Moreover, an environmental feature acting as a positive distraction should present the "ability to allow the individual to shift focus from negative foci within the health environment to the more restorative aspects of the non-medical world" (Shepley, 2006). Other authors underline that positive distraction should provide a soothing and stress-reducing effect (Khan et al., 2016; Park & Mattson, 2008, 2009a, 2009b).

Examining the positive distraction initiated by Ulrich gave rise to other studies in this domain. In the review of literature on positive distraction from 2006, the author distinguished three categories of interventions, namely nature, art, and music (Shepley). Even though the paper focused on a neonatal intensive care unit, the author analyzed the qualities of each category and provided design guidelines for practitioners. Simultaneously, researchers started testing other media of positive distraction such as multi-sensory stimuli combining artwork, music, nature, and light. For the past 20 years, the field has been developing with the use of

new interventions in different settings. A recently published literature review studied the impact of play and positive distraction on children in public spaces of healthcare settings (Jiang, 2020). While this article is a valuable attempt to organize the field of positive distraction, there is a need to review a broader spectrum of participants and healthcare spaces, which is the goal of the present paper.

RESEARCH OBJECTIVES AND QUESTIONS

Altogether, studies in the field of positive distraction investigated a variety of interventions in many settings on numerous outcomes. While empirical studies reveal valuable links between distractors and outcomes, the researchers in the field need to seek an explanation of how the positive distraction works. Establishing correlations between distractors and outcomes gave rise to the field, however, we need theories to develop our understanding of positive distraction. All in all, little is known about likely mechanisms accountable for the impact of positive distraction on outcomes. Moreover, the field lacks a clear categorization of distractors, as well as a framework to understand the relationship between positive distraction and outcomes.

This paper examines two primary research questions: (1) what is the state of the research field of positive distraction, and (2) what interventions plausibly result in what outcomes? I focus on four themes, namely nature, visual art, sound, and light. While the first three themes have been broadly studied, the latter emerges as an underexplored stimulus. Moreover, the combination of different themes offered novel, multi-sensory interventions. While the research on positive distraction has been conducted for almost 40 years, the technology to apply interventions has much evolved in the last 20 years. For this reason, this paper describes the field and reports on what has been studied in the last two decades. I focused on this timeframe to determine what interventions prevailed in the concurrent experiments and compare

both the traditional stimuli (nature, art, and music) with multifactorial interventions such as audiovisual interventions with light.

The objective is to describe the phenomenon of positive distraction, review the evidence on the impact of interventions on outcomes, and investigate the quality of the research of 40 experiments conducted in the past 20 years. Firstly, I explore the historic background of positive distraction, the definitions and concepts, and report on the categories of experiments. Secondly, I investigate the link between the categories and outcomes together with measures used to determine outcomes. I also investigate the relationship between interventions and different healthcare settings. Next, I analyze the evidence from the collected studies and the underlying mechanisms that are likely accountable for positive distraction. Finally, the goal is to report on promising directions and implications for practice.

RESEARCH METHODS AND PROCEDURES

Literature search

The present study is a systematic literature review of 40 peer-reviewed articles on positive distraction from the last 20 years. Three relevant electronic databases were searched (Web of Science, PubMed, and Google Scholar) using a combination of keywords. I grouped keywords into the following categories (1) positive distraction, distraction intervention; (2) nature, light, lighting, sound, music, art, visual stimuli, supportive design; (3) hospital, healthcare, clinic; and (4) outcomes, pain, stress, depression, satisfaction, medication, anxiety, agitation, sleep, behavior, perception, experience. The intent of using this large number of keywords was to find articles that studied phenomena connected to positive distraction but did not describe it as a positive distraction. These categories facilitated finding research on the impact of nature, art, sound, and light on psychological and physiological outcomes. The search included any study that referred to positive distraction in healthcare in the title or the abstract. Additional relevant studies were obtained from the reference lists of identified articles.

Literature screening and selection

As presented in Figure 1, the first step of this search resulted in 405 articles. Through the process of further search and selection, I included 40 peer-reviewed articles published in English between 2000 and July 2020 which studied cognitively healthy children or adults in a healthcare setting. I focused on positive distraction understood as an environmental feature in the following forms: representation of nature, sound, visual art, and light, and designed as

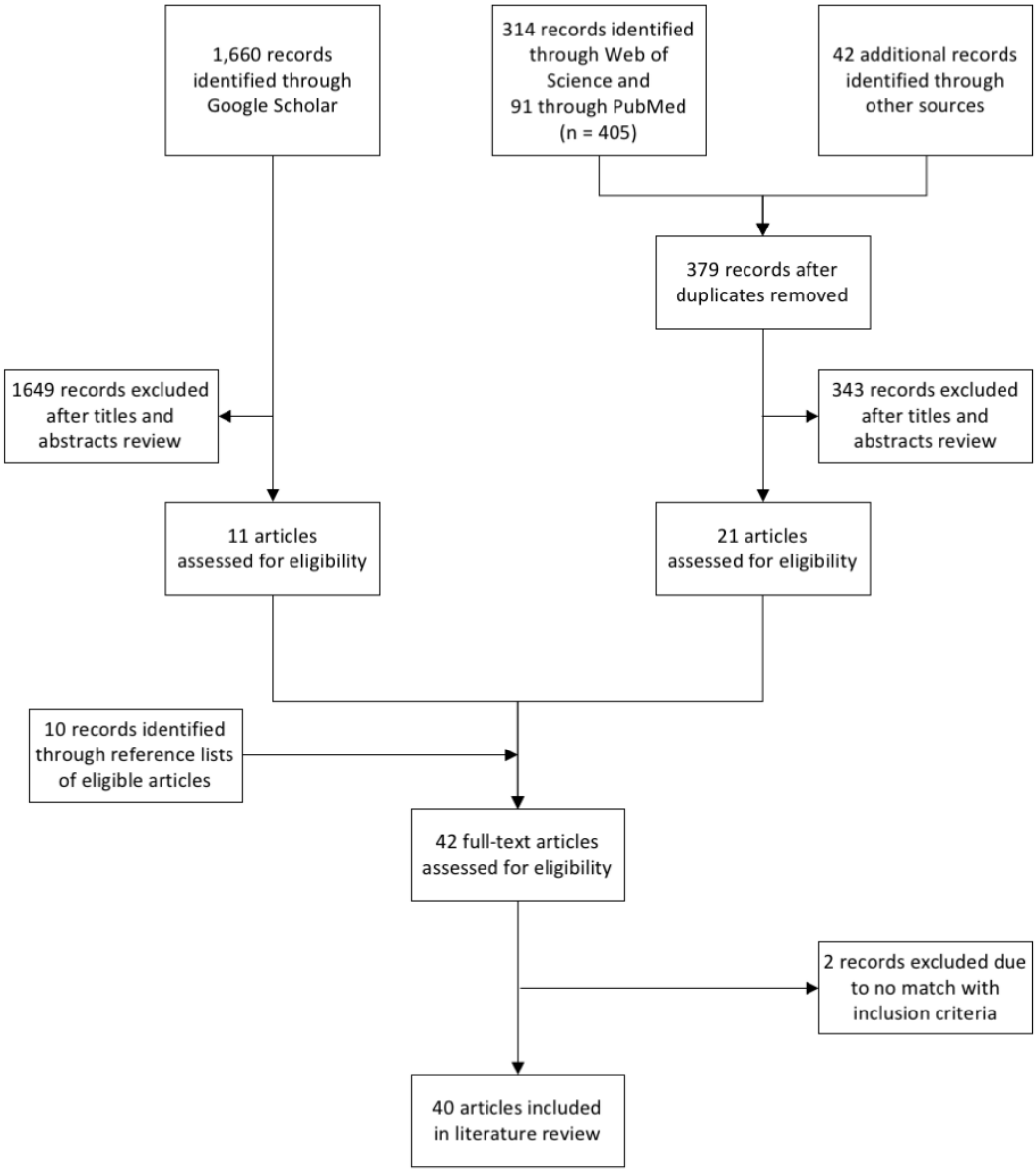

Fig. 1. Modified PRISMA flow diagram of literature search

Table 1 Summary of the Inclusion and Exclusion Criteria

Study characteristic	Inclusion criteria	Exclusion criteria
Study design	Experimental design; peer-reviewed articles published in English between 2000 and July 2020	Non-English studies published before 2000, non-experimental design, reviews, case studies, thesis
Population	Cognitively healthy children and adults able to communicate with speech	People cognitively impaired, patients under ventilation support
Interventions	Representation of nature, sound, visual art, and light; passive interactions; the same intervention for one study group	Virtual reality, exergaming, toys, parental distraction, activities guided by instructors, delivered through headphones, self-selected materials
Setting	Healthcare setting, including outpatient clinics, dental clinics, and simulations of a healthcare facility	Not a healthcare setting
Outcome	Patient's psychological, physiological, and behavioral	Not health-related or behavioral outcomes, preference

passive rather than guided interactions. Additionally, all participants from the same study group were exposed to the same positive distraction without the possibility to choose the intervention.

Exclusion of certain articles required further specification of Ulrich's definition, with emphasis on the notion of an environmental feature. Several groups of articles were excluded. Articles on virtual reality (VR), exergaming, and toys were excluded from the study because these interventions are not based on environmental features. Additionally, VR has a separate field of inquiry comprising several literature reviews. Similarly, studies on parental distraction were also excluded, as the definition of positive distraction does not include distractions presented by another person. Playing music, and any activity which involved instructions from researchers to focus attention on the stimulus were excluded, as they do not meet the definition of positive distraction employed in this study. Additionally, to analyze positive distraction, I eliminated studies that investigated inextricably both positive distraction and the sense of

control. Therefore, I excluded interventions allowing patients to self-select materials based on their preferences. Detailed inclusion and exclusion criteria are presented in Table 1.

Methods of analysis

Firstly, I analyzed the articles and organized the key information into a table (Appendix: Table 1). Based on the similarities of themes, I created categories and tagged the interventions. For each category, I attributed themes, modes of delivery, and content (Fig. 2). Then, I collected the outcomes and measures and created a framework. This framework presents the links between categories, outcomes, and measures which were employed to assess each outcome

as well as shows the number of studies that found beneficial influence for each category (Fig. 10). I excluded outcomes that were investigated in solely one article because it hinders comparison. Finally, I created a table that presents the number of articles that indicate statistically significant positive results for each category and outcomes (Fig. 11). Based on these results, I described the patterns for categories, healthcare spaces, and outcomes.

RESEARCH RESULTS AND FINDINGS

Overview of the studies

All articles analyzed healthcare patients in both inpatient and outpatient settings. Some studies were conducted in simulated hospitals. Almost all of the studies employed intervention versus no intervention condition. Two studies analyzed multiple interventions that fall into different categories, and therefore I treated each intervention as a separate case. For this reason, the number of articles from all the categories sums up to 42. Studies showed a considerable variation in the demographics, medical procedures, content of interventions, and mode of delivery. The vast majority of studies focused on adult patients (32 studies on adults, 9 studies on children, and 2 studies did not reveal the age of participants). The duration of

Categories	Theme	Mode of delivery	Content
Real and artificial nature (8)	Nature	Real plants, artificial plants and installations, window view	Foliage and flowering plants, Movable green walls, rock garden, Natural scenery (greenery, mountains and water), Aquatic, underwater
Visual representation of nature (6)	Visual Art Nature	Video (Screen), Images (Screen or canvas), mural, window mural	Foliage and flowering plants, Movable green walls, rock garden, Natural scenery (greenery, mountains and water), Aquatic, underwater
Music and Sound (12)	Sound Nature	Live, music pillow, loudspeakers	Live classical piano music, Soft instrumental music, Ambient electronic music, Popular, entertaining music, Various music (classical, disco, ambient), Traditional instrumental music, Nature sounds, Underwater sound
Light (2)	Light	Flashlight	Colors
Illuminated projection (5)	Visual Art Light Nature	Ceiling-mounted image, Projection on the wall	Child-friendly theme
Audiovisual (6)	Visual Art Sound Nature	Loudspeakers, Headphones, Video (Screen), Images (Screen or canvas)	Day and night sky, Child-friendly theme
Audiovisual with light (3)	Visual Art Sound Light	Loudspeakers, Headphones, Video (Screen), Images (Screen or canvas)	Day and night sky, Child-friendly theme

Fig. 2 Seven categories of positive distraction composed of interweaving themes. The preponderance of articles lies within two categories: Real and Artificial Nature and Music

exposure to positive distraction varied from a brief few-minutes examination to several days of hospital stay. Several studies reported some positive result(s), while others did not find any beneficial effects of positive distraction. It is noteworthy that studies that did not find any beneficial outcomes reported so. Also, depending on the healthcare setting, patients lay in different positions (supine, lying on their abdomens, etc.). Their ability to experience the

intervention differed, and therefore might have influenced the results of the studies. Based on the analyzed studies, I distinguished the following categories: (I) Real and artificial nature, (II) Visual representation of nature, (III) Music and Sound, (IV) Light, (V) Illuminated projection, (VI) Audiovisual, and (VII) Audiovisual with light. Each category consists of one or more interweaving themes, which are nature, visual art, light, and sound (Fig. 2). I included the following 19 outcomes that were investigated in at least two articles: anxiety, pain, heart rate, systolic and diastolic blood pressure (BP), respiratory rate, satisfaction, pain medication, stress, distress, length of stay, environmental satisfaction, reduction in restlessness, body temperature, calm behavior[1], perceived attractiveness, well-being, mood, relaxation (Fig. 10, Fig. 11).

I. Real and artificial nature

The field of positive distraction is deeply rooted in the tradition of horticultural therapy. Plants have been recognized to have therapeutic effects already many centuries ago and during the Middle Ages gardens were places where the sick could dwell and recuperate (Wong et al., 1997). The first form of positive distraction explored by Ulrich and the researchers who continued conducting studies in this field was the view of nature. Nature has been associated with reductions in stress, anxiety, pain, fear, increased satisfaction with nursing care, and decreased use of analgesics by patients, which led to empirical validation of reductions in length of stay (Pati, Freier, O'Boyle, Amor, & Valipoor, 2016; Salonen et al., 2014). The literature has been analyzing the impact of nature on psychophysical wellbeing through different theories. The restoration theory assumes that exposure to nature can help recover from directed attention fatigue, and thus improve the restorative experience (Kaplan & Kaplan, 1989). The biophilic and evolutionary theory implies that the evolution in nature bolsters the bond between humans and nature settings (Ulrich & Gilpin, 2003).

The long tradition of horticultural therapy, the concept of biophilia, and the initial interest of researchers in natural views might explain why Real and Artificial nature is one of the most

[1] Understood as decrease in movement (Pati & Nanda, 2011), indicated by talking in softer voices (Nanda et al., 2012)

Fig. 3 Example of an intervention in the Real and Artificial Nature category

Note: Reprinted from Blaschke, S., O'Callaghan, C. C., & Schofield, P. (2017). "Artificial But Better Than Nothing" The Greening of an Oncology Clinic Waiting Room. HERD: Health Environments Research & Design Journal, 10(3), 51-60.

numerous categories and the nature theme is widely present in other categories. The category comprises eight articles focused on natural and artificial plants as well as views of nature. Among these, we can distinguish the following interventions: real plants (Beukeboom, Langeveld, & Tanja-Dijkstra, 2012; Khan et al., 2016; Park & Mattson, 2008, 2009a, 2009b); artificial plants (Blaschke, O'Callaghan, & Schofield, 2017; Koh, Rashid, Khaw, & Nasis, 2019); natural outlooks (Emami, Amini, & Motalebi, 2018). These modes of delivery represented various types of contents such as foliage and flowering plants, movable green walls and rock gardens, natural scenery (greenery, mountains, and water), aquatic and underwater images. Six experiments studied adults, one studied both children and adults, and one study did not specify the age of participants. Five studies were conducted in the patient's room, two studies in waiting

rooms, and one in surgical wards. Figure 3 presents an example of artificial plants and green walls placed in an oncology outpatient clinic.

Altogether, studies investigated 13 outcomes and found some beneficial influence of interventions on each of the measured outcomes. Real and artificial nature is one of the two categories (alongside Audiovisual with light) that showed some health benefits for each measured outcome and thus emerges as one of the most prominent categories. It is noteworthy that six out of eight interventions were conducted for between 3 and 7 days. We can say that these were long-term interventions. Five out of six studies that measured anxiety and four out of four studies that measured pain proved positive beneficial effects. All of the studies that measured pain, systolic blood pressure, satisfaction, environmental satisfaction, perceived attractiveness, and mood found beneficial effects. However, the reason why only one out of four studies that measured diastolic BP found a positive impact, while four out of four studies found this effect for systolic BP was not explained. Further, while positive distraction is believed to reduce stress, no article investigated the impact of interventions on this outcome.

II. Visual representation of nature

Although this hypothesis has not been confirmed by researchers, it has been implied that real plants might be noxious due to bacteria in soil or water (Beukeboom et al., 2012). For this reason, it is a common practice to place a representation of nature in hospital settings. Initial research conducted by Ulrich was based on showing participants the slides presenting water and proved that these views attracted more attention (Ulrich, 1981). This category combines both visual art and nature and is mostly delivered through images on canvas or screen, videos, murals, and window murals. The most frequent content of these representations are landscapes, plants, greenery, mountains, water, or underwater. In this review, I collected six articles that investigated solely the visual representation of nature (Aburas, Pati, Casanova, & Adams, 2017; Beukeboom et al., 2012; Nanda et al., 2012; Pearson et al., 2019; Tse, Ng, Chung, & Wong, 2002; Vincent, Battisto, & Grimes, 2010). Figure 4 presents an example of a

Fig. 4 Example of an intervention in the Visual Representation of Nature category

Note: Reprinted from Nanda, U., Chanaud, C., Nelson, M., Zhu, X., Bajema, R., & Jansen, B. H. (2012). Impact of visual art on patient behavior in the emergency department waiting room. Journal of Emergency Medicine, 43(1), 172-181. doi:10.1016/j.jemermed.2011.06.138

combination of still and video art (flowers, landscapes, waterscapes) together with a window-within-a window effect. Two studies were on children, one study both on children and adults older than 14 years, one study on women in labor, and two studies solely on adults. Each study was conducted in a different healthcare setting, among these, we can differentiate laboratory, simulated patient room, emergency department waiting room, labor rooms, patient room. These articles found some beneficial effects for six out of eleven analyzed outcomes. All of the studies that measured pain, reduction in restlessness, and calm behavior found beneficial results.

III. Music and Sound

Music as a positive distraction draws from the long tradition of Music Therapy, which is known to date back to antiquity and treats music as a means to restore both mind and body (Horden, 2017). While not every study focused on music therapy can be analyzed as a positive distraction, these roots explain why Music and Sound is the most numerous category and counts 12 articles. Building on the definition coined by Ulrich, positive distraction is an environmental feature and its role is to provide passive distraction rather than guided interactions. The studies investigating solely music delivered through headphones were excluded since it is a guided intervention that dominates a patient's surroundings. The modes of

delivery of music and sound intervention are loudspeakers, music pillow (pillow with built-in loudspeakers), and live instruments. Figure 5 presents an example of a setting with the intervention delivered through a music pillow. The content of interventions varied from classical, soft instrumental, ambient electronic, popular and disco, live music to traditional instrumental music (Camara, Ruszkowski, & Worak, 2008; Caprilli, Anastasi, Grotto, Abeti, & Messeri, 2007; Hartling et al., 2013; Kristjansdottir & Kristjansdottir, 2011; Luis, Doss, Zayed, & Yacoub, 2019; Nilsson, Kokinsky, Nilsson, Sidenvall, & Enskär, 2009; Nilsson, 2009a, 2009b; Ovayolu et al., 2006; Reychler et al., 2015; Weeks & Nilsson, 2011). One intervention offered unspecified nature sounds delivered through a music pillow (Nikolajsen, Lyndgaard, Schriver, & Moller, 2009). Four studies were focused on children and eight on adults. Studies were conducted in a variety of settings, such as vaccination and blood test rooms, emergency department, pulmonary rehabilitation room, cardiac catheterization laboratory, cardiothoracic hospital unit, postoperative care unit (PACU), operating rooms, recovery room, colonoscopy room, and post-anesthesia care unit (PACU). The most promising result in this category is the reduction of pain. 6 out of 8 studies observed that music alleviates perceived pain. Three out of seven studies that measured anxiety found a beneficial effect. All studies that investigated distress found a positive impact of music, which is in line with the supposition that positive distraction mitigates stress (Shepley, 2006). Altogether, articles in this category investigated 12 outcomes and found

Fig. 5 Example of the Music setting with the use of music pillow

Note: Reprinted from Nilsson, U. (2009). Soothing music can increase oxytocin levels during bed rest after open–heart surgery: a randomised control trial. Journal of Clinical Nursing, 18(15), 2153-2161.

psychophysical benefits in 11 out of these, which supports the thesis that music is a potent positive distraction.

IV. Light

While the presence of daylight and direct sunlight is a key component for the patient's recovery (Nightingale, 1860), modulation of light might be an effective positive distraction. Daylight changing throughout the day and coming in the room through perforated shutters offers a play of shadows inside the room and therefore might engage the patient's attention (Fig. 6). Moreover, the development of tunable dimmable LED technology gave rise to rapid changes in the field of lighting. Companies in the lighting industry design products to cater not only to the needs of safety and visual comfort but also to create a pleasant environment and entertainment. Researchers have studied the calming and entertaining effects of subtly varying lighting (Hooijman & Cuijpers, 2018) as well as the stress-recovery effects of pulsating lighting (Wan, 2011).

Fig. 6 Visualization of the modulation of daylight as a positive distraction

Note: Reprinted from Kopka, M. A. (2017). Children's hospital in Poznan. How can architecture contribute to the healing process of children in the pediatric hospitals? (Unpublished master's thesis). Poznan University of Technology, Poland.

However, the use of light as a positive distraction has been little studied. I identified two articles that studied lighting interventions. Both used flashlights with white, blue, and red light (Bakan, 2017; Rahimi, Makarem, & Rooyan, 2013). One research studied adults in the operating room and another studied children in the blood collection unit. Both studies found a statistically significant positive impact of the intervention on pain. One study investigated stress, however, found no effect. Even though these studies started an interesting line of inquiry, there is room for the development of lighting interventions. Drawing inspiration from illuminations in public spaces or interactive illuminations of buildings' facades, the lighting interventions in healthcare spaces might be further developed to create a soothing environment. The analyzed articles did not provide a visualization of the lighting interventions. Figure 6 presents an example of how the daylight can be modulated through the shutters to act as a positive distraction.

V. Illuminated projection

Illuminated projection is a multifactorial category composed of two principal themes: visual art and light, and in some cases completed with the theme of nature. Delivered through projection or ceiling-mounted sky compositions, the images of landscapes, day and night sky, and child-friendly themes are designed to enhance the patient's experience. Altogether five studies investigated this category: two studied child-friendly themes (Carwile, Feldman, & Johnson, 2014; Quan et al., 2016), and three investigated nature (Bonett, 2015; Pati et al., 2016; Zijlstra, Hagedoorn, Krijnen, van der Schans, & Mobach, 2017). Figure 7 presents an example of day and night sky ceiling composition in a radiation therapy department. One study investigated children in radiography rooms, others studied adults in colposcopy examination rooms, computed tomography (CT) imaging rooms, and patient room. Four studies examined anxiety, however, found no impact. Two out of two studies that tested diastolic BP and environmental satisfaction found beneficial health outcomes. Similar to the category of real and artificial nature, a disproportionate number of studies found a beneficial impact on systolic and diastolic BP. While two studies found an impact on diastolic BP, none found an impact on

systolic BP. Moreover, this is an inverse relationship than for the experiments with nature, where the positive impact was exposed to systolic BP. The reason behind this disparity is not explained.

Fig. 7 Example of an intervention in the Illuminated Projection category

Note: Reprinted from Bonett, J. (2015). Ceiling art in a radiation therapy department: its effect on patient treatment experience. Journal of medical radiation sciences, 62(3), 192-197

VI. Audiovisual

Audiovisual interventions combine two themes: sound and visual art. While looking at images or representations of nature, patients also hear sounds. In this review, I identified six articles investigating this multifactorial intervention. We can distinguish images of nature with accompanying nature sounds (Diette, Lechtzin, Haponik, Devrotes, & Rubin, 2003; Lechtzin et al., 2010; Nikolajsen et al., 2009; Watts, Khan, & Pheasant, 2016), images with music (Nielsen, Wåhlin, & Frisman, 2018; Pati & Nanda, 2011). One study examined pediatric patients in waiting areas of two clinics. Other studies examined adults in the flexible bronchoscopy (FB) room, bone marrow aspiration, and biopsy procedure room, operating room, and post-anesthesia care unit (PACU). Figure 8 presents an example of an intervention that delivers movies with nature sights and music with nature sounds. Studies investigated 13 outcomes, but single articles found positive effects on pain, restlessness, and calm behavior. Even though these results might not seem promising, only 12.5% of articles investigated audiovisual interventions, which may not be representative.

Fig. 8 Example of an intervention in the Audiovisual category

Note: Reprinted from Nikolajsen, L., Lyndgaard, K., Schriver, N. B., & Moller, J. F. (2009). Does audiovisual stimulation with music and nature sights (MuViCure) reduce pain and discomfort during placement of a femoral nerve block? Journal of PeriAnesthesia Nursing,

VII. Audiovisual with light

Another distinguished category combines visual art, sound, light, and in some cases, nature. This category is represented by three articles with the following interventions: a combination of dynamic colored ambient lighting, video projections of nature imagery, and sound (Klaming, Van der Zwaag, Van Minde, & Geraedts, 2013); video with nature scenes, static monochrome colored lighting in the rims around the installation and ambient electronic music (Vogel et al., 2012); projection of video with photographs of landscapes of the province and views of the city of Granada together with relaxing music (Gómez−Urquiza et al., 2016). It is noteworthy that the second intervention displayed colorful lighting that dynamically adapted itself to the colors presented on the television screen (Fig. 9). We can infer that Vogel et al. created a holistic approach to creating a patient's environment with image, sound, and light. All three studies examined adult patients in an X-ray room, positron emission tomography (PET) uptake room, and waiting room before surgery. Notably, articles in this category found beneficial impacts of the intervention on each of the investigated outcomes. Two out of three articles found positive effects on anxiety, two out of two — on heart rate, diastolic and systolic BP, and respiratory rate. Also, one article that studied satisfaction and stress reported positive results.

Even though this category is represented by three articles, these results seem promising, and therefore audiovisual interventions with light are worth pursuing in future research.

Fig. 9 Example of an intervention in the Audiovisual with Light category

Note: Reprinted from Vogel, W. V., Olmos, R. A. V., Tijs, T. J., Gillies, M. F., van Elswijk, G., & Vogt, J. (2012). Intervention to lower anxiety of 18F-FDG PET/CT patients by use of audiovisual imagery during the uptake phase before imaging. Journal of Nuclear Medicine Technology, 40(2), 92-98.

Healthcare settings and patient's experience

The studied interventions were placed in a variety of settings (Fig. 10). The most common interventions were plants placed in patient rooms as well as Illuminated projections and Audiovisual interventions with a light placed in diagnostic imaging rooms. We can deduce that real and artificial nature was placed mainly in patient rooms as a long-term intervention due to a sort of steadiness of nature, which enhances relaxation. On the other hand, interventions in multi-factorial categories were mainly situated in waiting rooms, exam and diagnostic rooms, laboratories, and procedure rooms with intent to distract over a short period. However, many articles did not provide the reason why certain interventions were placed in a given healthcare setting. To better utilize the positive distraction, we need to understand the qualities of each type

of intervention as well as the experience of a patient in each healthcare space. Once we understand the patient's experience, we will be able to determine what type of intervention is

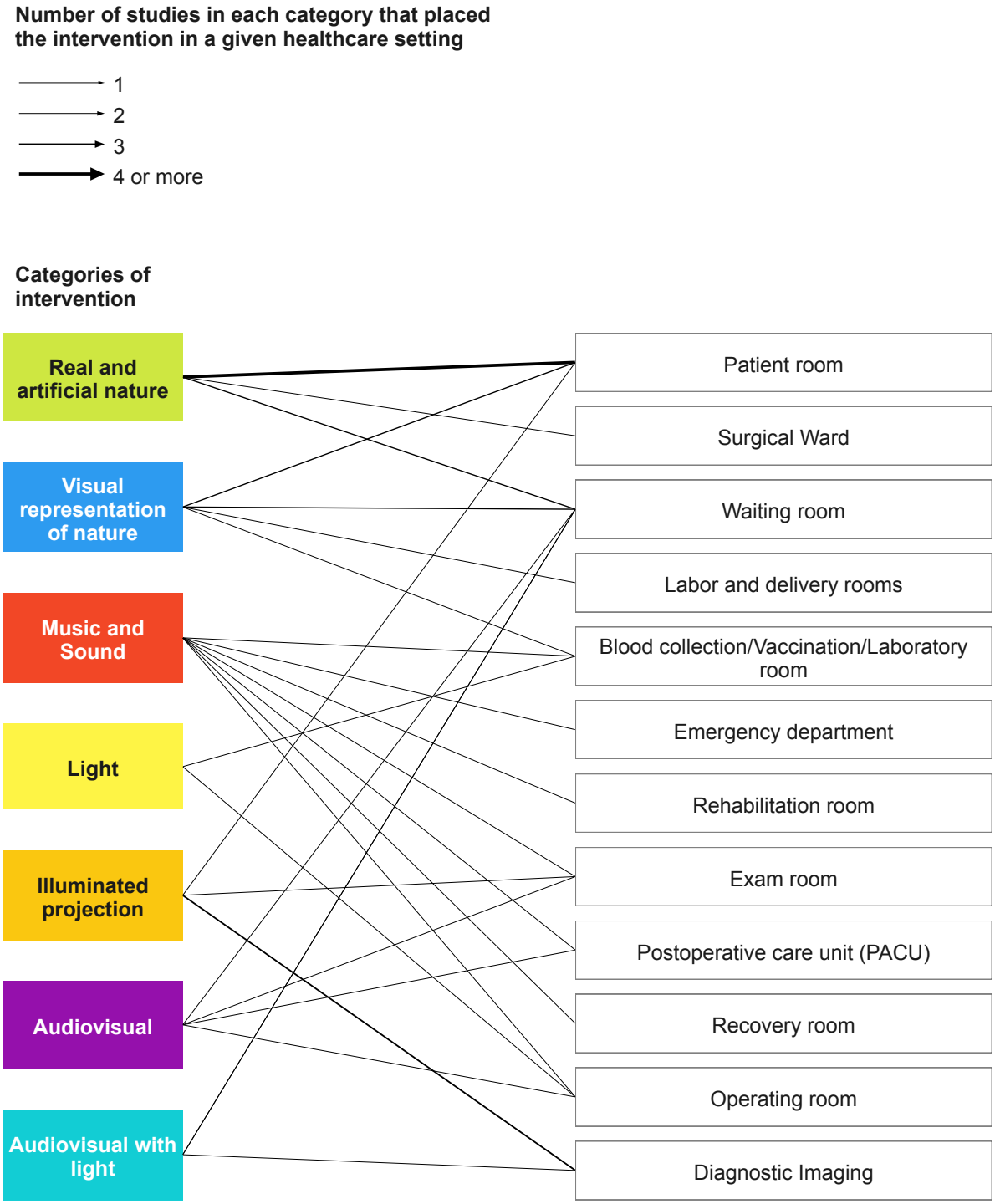

Fig. 10 Categories linked to healthcare settings. The most common interventions were plants placed in a patient room as well as Illuminated projection and Audiovisual interventions with light set in diagnostic imaging rooms.

needed in this space. For instance, to alleviate acute stress in a blood collection room or anxiety in a waiting room, we could place a distracting dynamic intervention. On the other hand, to provide a relaxing experience during bed rest, we could place a harmonious intervention like classical piano music or the composition of natural plants. Moreover, the type of intervention will not only depend on a given healthcare setting but also on the type of procedure conducted in this space. For example, patients undergoing ocular surgery will lie in a different position and will have available different senses than patients undergoing spine surgery, even though both procedures will be conducted in an operating room. Additionally, one study placed plants on the surgical ward (Khan et al., 2016), but did not specify whether the intervention was set in the corridor, patient room, or elsewhere. The difference in time spent passing the corridor versus time spent in the patient room is tremendous. Altogether, researchers should consider the experience of patients in a chosen healthcare setting, subsequently the adequate intervention, and finally which outcomes should be measured (Fig. 11).

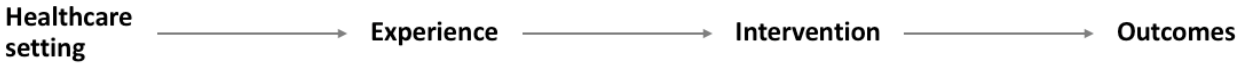

Fig. 11 Process of applying positive distraction in healthcare settings

Measures and outcomes

Altogether, studies explored 44 outcomes. More than half of the outcomes were investigated by no more than one study and therefore were excluded from this analysis. Outcomes and measures employed to assess these outcomes are shown in Figure 10. While some measures are commonly used in research and were employed to assess multiple outcomes (Visual Analog Scale, Numeric rating scale, Faces Scale, Likert Scale), others were designed specifically for a given study. Using the major scales enables us to replicate studies and compare them. While new tools might enable a more customized research design, the results will be harder to compare with other findings coming from different methodologies. Some

of the outcomes seem to be related, e.g., anxiety, stress, and distress. Moreover, some measures such as vital signs (blood pressure, heart rate, respiratory rates) can be used as markers of constructs such as pain, anxiety, or stress. In this review, I report the collected outcomes the way they appeared in the analyzed studies. In most papers, vital signs were measured as discrete outcomes and not as markers of other outcomes.

Having proved that distraction matters, most studies rely upon the statistical significance and do not show what is the effect size of the intervention. The studies lack the information regarding the dosage of positive distraction and for how long a patient needs to be exposed to the intervention to experience beneficial effects. Moreover, there is no insight concerning the duration of positive effects.

Summary of the distribution of existing studies

The analysis of the evidence from each category of intervention suggests that there is a positive correlation between positive distraction and outcomes. Multiple studies found beneficial effects of different interventions on numerous outcomes (Fig. 10, Fig. 11). The outcomes which were the most studied are anxiety, pain, heart rate, systolic and diastolic BP, and respiratory rate. More than half of the studied articles measured anxiety and pain (24 and 22 out of 40, respectively). Even though the studies employed different measures, 16 out of these studies found a statistically significant improvement in perceived pain. However, less than half of the articles that measured anxiety found any beneficial effect. Although the positive distraction was initially recognized for its stress-reducing potential, stress and distress were investigated collectively in only eight out of 40 articles. More than half of those studies found positive effects, which is a promising result. Even though a small number of articles investigated environmental satisfaction and calm behavior (four and three, respectively), all the results indicated beneficial effects for both outcomes. More than 60% of studies that measured the impact of interventions on pain, satisfaction, environmental satisfaction, reduction in restlessness and calm behavior, and perceived attractiveness found positive statistically significant results. However, the most

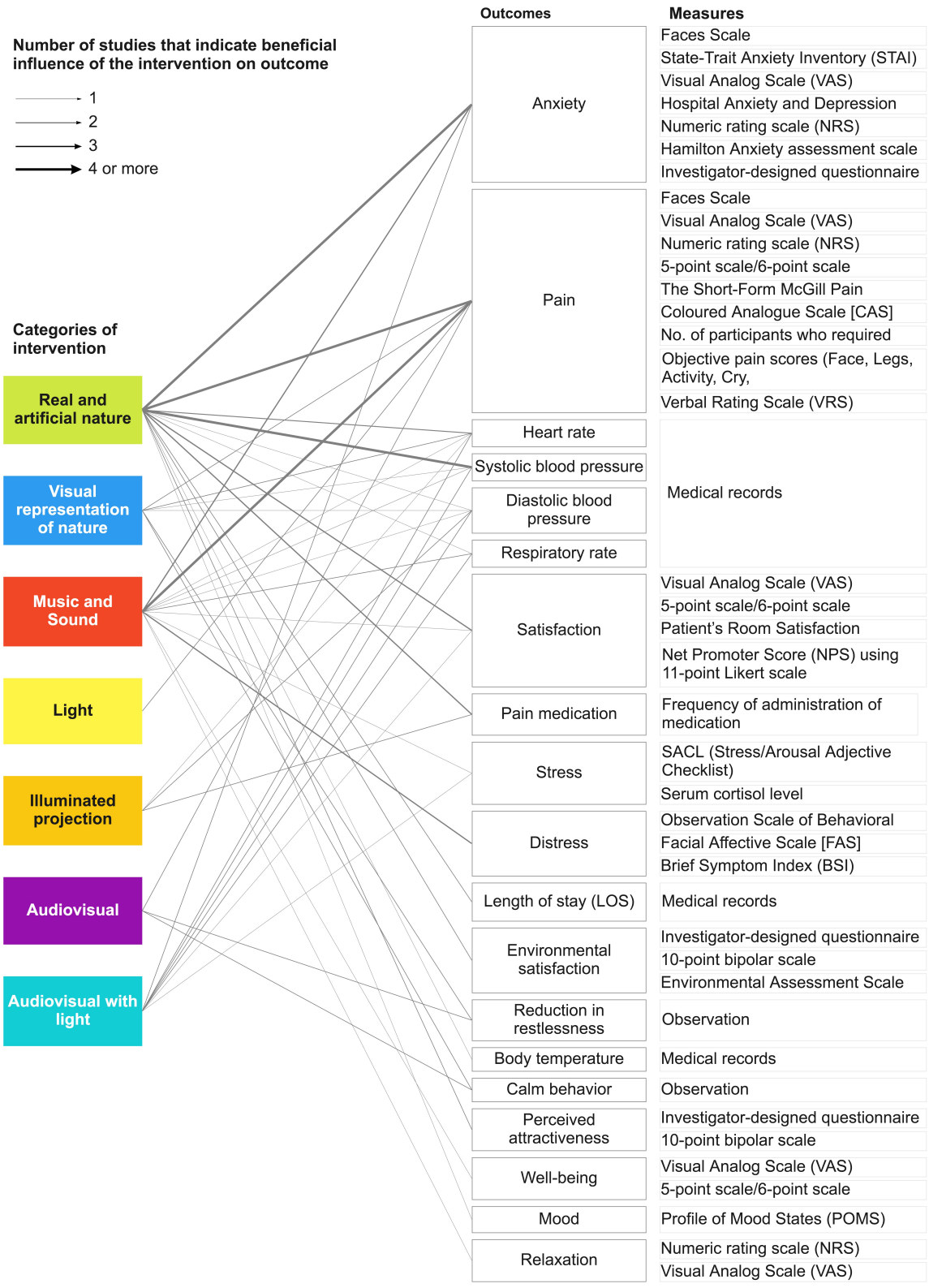

Fig. 12 Categories linked to outcomes and measures used to determine outcomes. Interventions in the Real and Artificial Nature and Music and Sound categories are linked to more then 10 beneficial outcomes.

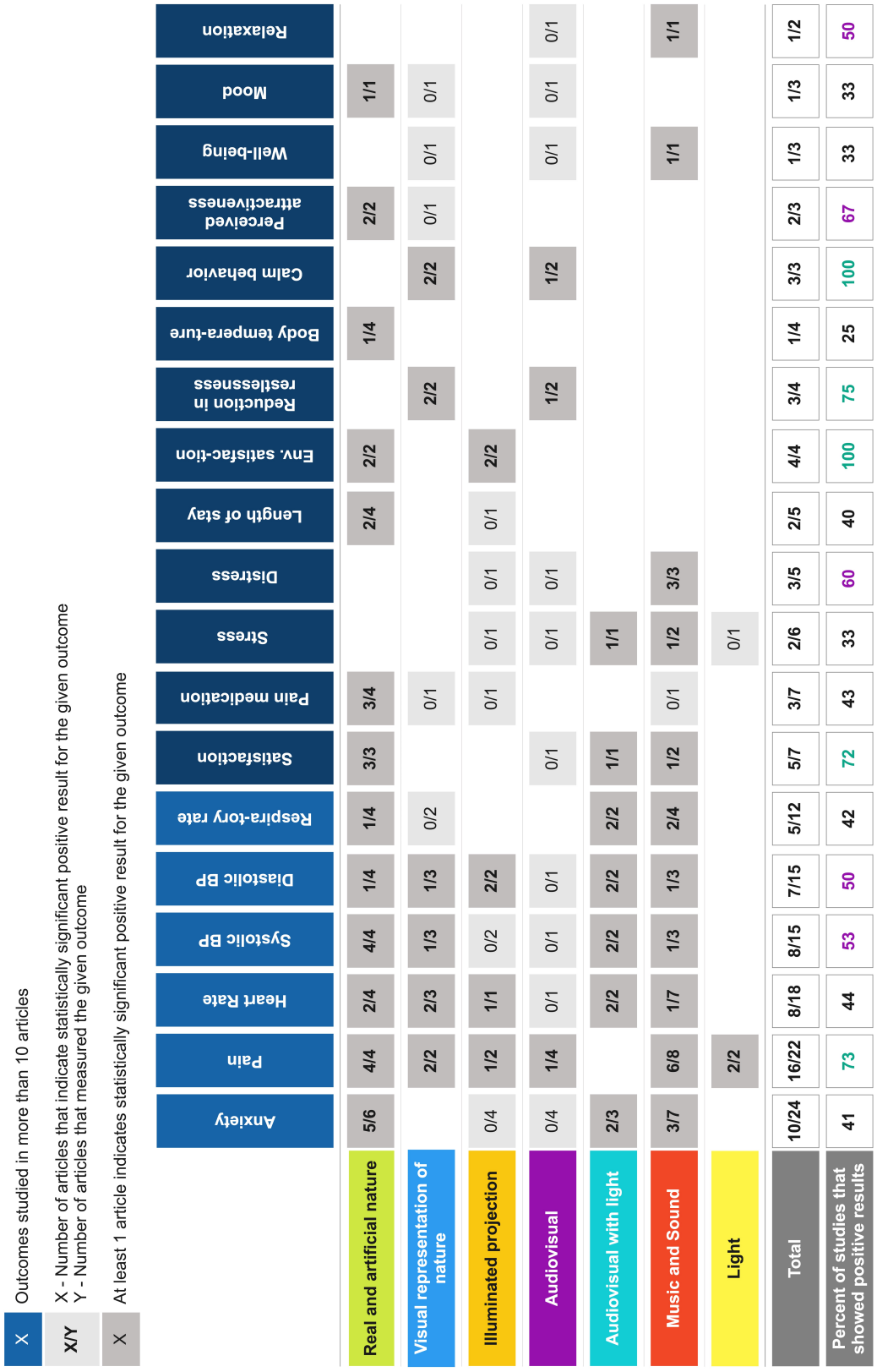

Fig. 13 Overview of the results for each category and outcome

prominent categories are Real and Artificial Nature and Music and Sound with eight and 12 articles, respectively. Both categories showed beneficial links between interventions and more than ten outcomes. Out of multifactorial categories (Illuminated projection, Audiovisual, and Audiovisual with light) the last category emerges as the most beneficial. The articles in this category showed improvements in the level of anxiety, heart rate, systolic and diastolic blood pressure, respiratory rate, satisfaction, and stress. Moreover, this category demonstrates a comprehensive approach toward creating a soothing healthcare environment.

Theories and explanations

One of the research gaps I identified is the lack of explanation of mechanisms accountable for positive distraction and its impact on outcomes. The field emerged from the cognitive coping strategies for pain, namely imagery and attention-diversion technique as a means of alleviating pain (Fernandez, 1986). These techniques might be an answer to how positive distraction works. Nevertheless, analyzed studies often do not elaborate on mechanisms, but rather base their theories on the results from previous studies. The research in the domain of positive distraction is mostly empirical, and thus many studies do not offer explanations of mechanisms behind positive distraction. Figure 14 presents the theories and mechanisms suggested in the examined articles. Two papers present a similar mechanism, which assumes that flowering plants increase the perceived attractiveness of the space, and thus reduce patient's response to stress (Beukeboom et al., 2012; Koh et al., 2019). One of the authors suggests another possibility that the natural vista improves mood, and thus improves subjective comfort (Koh et al., 2019). The authors of the music experiment discuss the gate control theory (GCT) and relate it to the cognitive coping strategies (Kristjansdottir & Kristjansdottir, 2011). Nilsson implies that listening to music improves a patient's wellbeing, and thus enhances oxytocin release (2009b). From another perspective, researchers who investigated visual art suggest that it reduces restlessness and people-watching, which in turn induces a reduction in noise level in a given space, and therefore lowers the stress level of

patients and staff (Nanda et al., 2012). However, the mechanisms suggested in the papers show empirical correlations, but not scientific explanations. In order to provide a positive distraction that brings the intended result, such as relaxation or engagement, we need to understand the underlying scientific process.

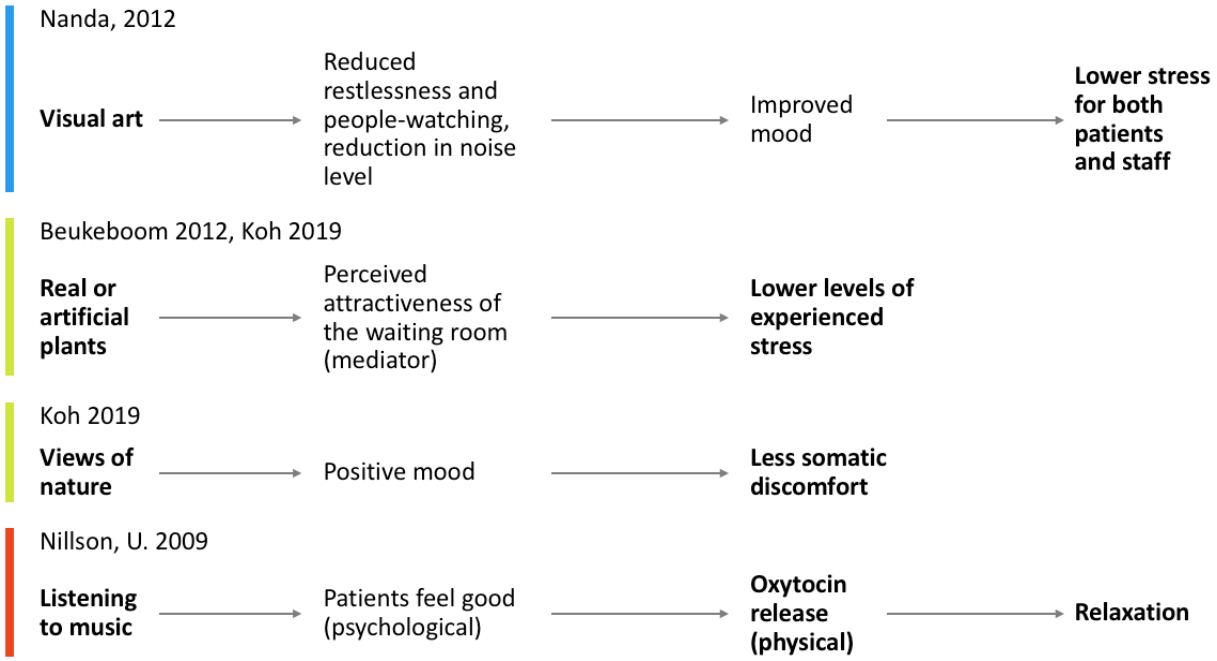

Fig. 14 Mechanisms suggested in the studies show empirical correlations, but not scientific explanations

Another explanation might be based on the Attention-Diversion concept, which supports that perception of pain decreases when the attention is directed away from a painful stimulus. The results from the experiment conducted by Petrovic et al. show that participants rated the intensity and unpleasantness of pain significantly lower when they were simultaneously presented with both painful stimuli and an attention-demanding task (2000). These findings suggest that actively directing attention from a painful stimulus and towards cognitively demanding tasks results in the reduction of pain perception (Petrovic et al., 2000). The field is still based more on correlation rather than a theoretical approach. A different interesting path is to investigate the neuroscientific approach. An experiment conducted in 2017 in the Neuroscience Program and the Department of Psychology focused on the impact of different

arousal levels on cognitive processing (Iordan & Dolcos, 2017). In this experiment, participants were asked to perform a working memory task while the Functional Magnetic Resonance Imaging (fMRI) data were recorded. At the same time, participants were presented with positive and negative pictures as distractors. The study reports that similar arousal-dependent mechanisms may be partially engaged by both positive and negative distractions. However, both stimuli have differential impacts on concurrent cognitive performance. This effect is connected with valence dissociations in how the regions responsible for basic emotion processing and higher-level cognitive control are engaged and coupled together. The findings show that positive distraction is linked to the reduction in cognitive interference. Also, participants coped better with positive distraction as compared to negative distractions. These findings, although focused on working memory, imply that there are differences in how the brain processes positive and negative distractions. It also underlines the differential impact of both stimuli on emotion processing. Further research should seek an explanation of how positive distraction may affect health outcomes through adequate brain processes. Most studies in the field of positive distraction established an empirical link between an environmental feature acting as a positive distraction and psychophysiological aspects. Environmental research coupled with a neuroscientific approach could determine an explanation behind this theory.

DISCUSSION

This paper reported on 40 peer-reviewed publications from the last 20 years to analyze the role of nature, visual art, sound, and light as a positive distraction in the patient's experience in healthcare settings and the associated psychophysiological outcomes. My analysis revealed that these interventions can be categorized into seven following categories: Real and artificial nature, Visual representation of nature, Music and Sound, Light, Illuminated projection, Audiovisual, and Audiovisual with light. These categories differ from the ones

presented in a recent literature review (Jiang, 2020). However, this difference is not surprising, since my review focused on a broader topic in terms of participants and healthcare settings.

The most common interventions analyzed in this paper were plants placed in a patient room as well as Illuminated projection and Audiovisual interventions with light set in diagnostic imaging rooms. The interventions are also linked to several outcomes, among which the most frequently studied are anxiety, pain, heart rate, systolic and diastolic blood pressure, and respiratory rate. The results of this analysis are mixed with some studies that reported some positive result(s) and others that did not find any beneficial effects of positive distraction. This study confirmed that a large number of studies found that positive distraction reduces the level of perceived pain. Half of the articles report the beneficial influence of positive distraction on anxiety. Surprisingly, stress and distress were investigated in a relatively small number of studies, and therefore the results are inconclusive. This result is unexpected since positive distraction was initially recognized for its stress-reducing potential (Shepley, 2006). Asking why the stress was investigated in so few cases, it is hard to give one good answer. But speculating about this topic, it is possible that some disciplines are not interested in studying stress, or that researchers tend not to publish failures of replicated studies. Another possibility is the difficulty of employing several measures and among these measures to investigate stress. In any case, there is not one satisfying answer to this question.

Even though environmental satisfaction and calm behavior were investigated in a small number of articles, the results indicate a beneficial impact of interventions on both outcomes. Altogether, this analysis supports that positive distraction has a beneficial impact on some physiological and psychological outcomes. The most prominent categories are Real and Artificial Nature and Music. Both categories showed beneficial links between interventions and more than ten outcomes. Out of multifactorial categories, Audiovisual with light showed improvements in several outcomes, and thus emerges as the most promising. Moreover, this category demonstrates a comprehensive approach toward creating a soothing healthcare environment.

There is insufficient knowledge regarding mechanisms accountable for positive distraction. Some studies suggest possible relationships between intervention and outcomes (Fig. 14), however many do not elaborate on the theories supporting this empirical link. Among the mentioned concepts, there are gate control theory, cognitive coping strategies, such as attention-diversion technique, and neuroscientific approach. Other explanations suggest processes, e.g. through the increase of perceived attractiveness of the space, positive distraction reduces patient's response to stress (Beukeboom et al., 2012; Koh et al., 2019), positive distraction improves mood and in consequence — subjective comfort (Koh et al., 2019), listening to music improves patient's wellbeing, and thus enhance oxytocin release (Nilsson, 2009b), or visual art reduces restlessness and people-watching, which reduces the degree of noise and lowers the stress level (Nanda et al., 2012). To broaden our understanding of the phenomenon of positive distraction, we need to determine the mechanisms accountable for the impact of positive distraction on outcomes.

Limitations

Due to a small number of studies in the domain of positive distraction, I included studies with different methodologies. Some interventions which qualified for this review derive from horticultural and music therapy and this might be the reason why the prevalence of articles falls into Real and Artificial Nature and Music and Sound categories. Altogether, the studies varied in the demographics, duration of exposure, medical procedures, and healthcare settings. Also, the outcomes were assessed with different measures. Consequently, these dissimilarities in methodology may have impeded an explicit comparison of the interventions. Another limitation is the process of literature search. Although I employed multiple ways of searching for articles (electronic databases, reversed citations, references in the eligible articles), there is a risk that I did not reach all the materials that would qualify for this review. In such a case, the results might not represent the whole spectrum of the field, but rather the identified part. Further, I focused solely on positive distraction and selected studies that did not provide a choice of intervention to

the participants. To compare interventions, I selected studies that administered the same positive distraction to one study group. For this reason, I eliminated studies that investigated inextricably both positive distraction and the sense of control. Once we gain a deeper understanding of the distractors, we should investigate the role of choice in the phenomenon of positive distraction. The Theory of Control is a separate domain, which should be incorporated in future research.

Furthermore, this analysis of the evidence was based on the statistical significance of the results of each study. It is noteworthy that statistical significance indicates that a given result is unlikely to happen by coincidence. To have more practical results, the studies should determine what is the effect size. In other words, research needs to assess what is the magnitude of the intervention. The studies should not only indicate whether the intervention affects participants, but also to what extent it affects them. Analyzing the statistical significance limits the capability to sharply examine the phenomenon of positive distraction.

Definitions

In this paper, I provided the most common definitions of positive distraction. However, looking at these definitions more closely, it appeared to me that there are two different aspects of the term, and these are *distraction* and *engagement*. To *"distract from"* has a notion of a short-term impulse. On the other hand, to *"draw attention"* connotes an engaging element, intriguing object, or situation. Despite the nuances of the meanings, both denotations are used interchangeably in the literature on positive distraction. However, such differentiation could be based on the duration of exposure. In the examined literature, the duration of the intervention varied from 10 minutes to 7 days. The long-term interventions were common for the category of nature and the interventions placed in the patient room. These were mainly plants, images, objects that could draw attention and engage over a longer period. The short-term interventions were mainly flashes of light and animations that could distract from a quick procedure conducted, for instance, in the radiography room or examination room. Further studies on the

difference between distraction and engagement are necessary to assess whether all the interventions can be categorized under the umbrella of positive distraction. Such an analysis might reveal that the term positive distraction could be further divided into more specific sub-terms.

Future directions

My initial research interest revolved around light as a positive distraction. Surprisingly, despite the rapid development of lighting technologies and practical applications of LED systems, only two studies investigated lighting as a positive distraction. However, lighting was a key component of interventions categorized as Audiovisual with Light. These experiments proved to bring beneficial health outcomes, and therefore are worth pursuing in future studies. Multi-sensory interventions, such as video projections of nature imagery with sounds and accompanying colored lighting, were linked to several healthcare benefits. Similar studies should be replicated to corroborate the results from the three analyzed articles.

Future research should develop a detailed description of the beneficial features of distractors. Namely, it should aim to determine what are the features of the given stimulus which brings beneficial effects. There are different hints, such as the biophilic theory, the notion of familiarity (views of Grenada, sounds of a traditional Egyptian instrument), or aesthetics and pleasantness of the space. Determining the variables could be an effective way to help design positive distraction that brings beneficial health outcomes. Moreover, in the interest of broadening the understanding of the phenomenon, researchers should investigate mechanisms accountable for the impact of positive distraction on outcomes.

As mentioned earlier, future studies should determine what is the effect size of a given result. Information about statistical significance is valuable for the credibility of the results. However, to draw conclusions for practice, it is necessary to determine the effect sizes of interventions. Concerning the methodology of the studies, it is vital to report detailed information, such as the age of participants, at what point the measurements were taken, etc.

Papers should provide a visualization of distraction or, in the case of non-visual distractions such as sounds, a detailed description of a stimulus. Not every study provided this information which obstructs the understanding and analysis of the intervention.

Further, the nature of the studied problem imposes methodological difficulties for conducting research. Unlike in laboratory studies, research in the field of Evidence-Based Design faces the challenge of creating the same setting for both experimental and control groups. In the case of measuring positive distraction, aspects like environmental context, the presence of people, family visits, other problems occupying the patient's mind can influence the results of the study. For this reason, studies need to employ an adequate sample size as well as create identical conditions for both groups. A good example of minimizing the differences between experimental and control group is to set the experiments in identical rooms (except for the intervention), match patients in pair regarding the demographics, and provide that both conditions are in the same proximity from the nursing station, and thus equally exposed to any ambient noise as employed by Pati et. al. (2016). Researchers should carefully choose the setting and context of the experiments as the results might be compromised by any of these aspects.

Finally, future studies should couple academic research with the work in the industry and replicate the previous interventions. The articles that I collected in this paper are often single, one-time experiments. To conduct more extended reviews and compare specific stimuli, demographics, healthcare settings, etc., we need more experiments that are alike in terms of interventions and methodology.

CONCLUSION

The goal of this study was to describe the phenomenon of positive distraction, review the evidence on the impact of interventions on outcomes, and investigate the quality of the research conducted in this field. I investigated what are the categories of interventions, their link with

outcomes and healthcare settings, theories behind underlying mechanisms, and the evidence that positive distraction affects patients' outcomes. Still, this paper was bound by the following limitations: incorporation of studies with different methodologies, risk of not finding every existing study qualifying for this review, separating positive distraction from the sense of control, and analysis based on the statistical significance of the results.

As expected from our experience and the literature, this analysis of 40 experiments conducted in the field of positive distraction confirmed that there is a positive correlation between positive distraction and outcomes. The most frequently investigated outcomes are anxiety, pain, heart rate, blood pressure, and respiratory rate. Although the positive distraction was initially recognized for its potential to reduce stress, only eight articles investigated stress and distress. Yet still more than half of those studies found a beneficial effect. This result seems promising but needs further exploration in replicated studies. There is strong evidence that positive distraction helps reduce perceived pain. Even though a small number of articles investigated environmental satisfaction and calm behavior, the results indicate beneficial effects for both outcomes. Categories which turned out to be the most promising are Real and Artificial Nature, Music and Sound, and Audiovisual with light. These three categories showed beneficial links between interventions and several outcomes. Moreover, interventions categorized as Audiovisual with light demonstrate a comprehensive approach towards creating a soothing healthcare environment and an interesting direction for the development of the field. On the contrary, lighting emerges as an underexplored stimulus. Both, modulations of daylight and artificial light give possibilities to explore light as a positive distraction.

Despite the 40-years tradition, the field of positive distraction is still in an exploratory phase. Researchers have been testing new forms of interventions in new settings and my goal was to bridge this gap of the lack of systemization in this field. The significance of this study lies in collecting and analyzing the studies, describing the crucial aspects that need to be considered when designing positive distractions, and pointing out the directions for future research. This study aimed to broaden our understanding of the concept of positive distraction.

Although the empirical link between distractors and outcomes is significant, little is known about the underlying theories and mechanisms.

One of the crucial aspects that researchers need to determine is the effect size of positive distraction. To better understand and utilize positive distraction, it is vital to understand for how long the intervention needs to be administered in order to bring beneficial effects and in what dosage. The current research lacks information on how much difference the positive distraction brings. Future work needs to quantify the results and determine the magnitude of interventions.

Another key facet is understanding the nature of the problem and the challenges that research on positive distraction faces. Since we lack guidelines for appropriate positive distraction in the right healthcare settings, the existing research tested incidental interventions. For this reason, it is important to determine what experiences patients face in different healthcare settings and what qualities of interventions will mitigate the negative experiences. Moreover, the quality of the research needs to be improved, namely the methodological approach. The environmental context such as the healthcare setting is harder to control than a laboratory experiment, and therefore measuring the impact of positive distraction is a complex task. The experiments should take the form of randomized controlled trials to eliminate differences between experimental and control conditions.

Furthermore, it is important to stress the distinction between distraction and engagement. The interventions analyzed in this work display different characteristics regarding the duration and nature (static or dynamic) of experiments, prevailing settings, and intended experience (relaxing, engaging, distracting). Future work should consider the division of the term positive distraction into more precise sub-terms taking into account the aforementioned differences.

Future research should focus on defining the beneficial features of the distractors, explaining the underlying mechanisms, determining the effect size of interventions, and improving the quality of studies. In sum, this analysis described interesting directions to pursue

in the field of positive distraction both for theoretical research and practice. Nevertheless, to gain more understanding on the beneficial characteristics of positive distraction, further research is required. Despite the extensive analysis, the research on positive distraction is very heterogeneous, and for this reason, no good recommendations for practice can be given beyond the commonsensical.

IMPLICATIONS FOR PRACTICE

- It is beneficial to integrate plants and ambient music in hospital wards as well as install multi-sensory interventions in exam rooms. Similarly, installing a photographic display with music in waiting rooms can be an effective way to engage patients' attention before healthcare procedures. However, it is unclear what dosage and for how long the distraction should be administered to bring beneficial effects.
- Examine what experiences patients have in different healthcare settings and which interventions could mitigate the negative experiences or enhance the positive ones.
- When designing a positive distraction, take into account the visual quality and aesthetics of intervention as well as the patient's position so that the distraction is in their field of view.
- Currently, most positive distractions are elements added to the interior. Consider integrating positive distraction at an early stage of the architectural design process.
- Explore how the aspects of controllability and personalization affect patient's experience of positive distraction.
- Because positive distraction comes out of other fields, use the opportunity to collaborate between the fields. For example, light experts can create interventions in cooperation with music therapists.

APPENDIX: TABLE 2

Table 2 Detailed Information on the 40 Peer-Reviewed Publications Included in This Literature Review

	Author	Study design	Setting	Participants	Intervention	Comparisons	Outcomes/Results	Methods	Duration
I. Real and artificial nature	Park & Mattson, 2008	Randomized controlled trial	Patient room	- 90 adult patients after appendectomy - 21 - 60 years (52 males and 38 females, mean age 37.6 years) - randomly assigned	Foliage and flowering plants	Foliage and flowering plants vs. no plants	Experimental group has following improvements: fewer intakes of postoperative analgesics, lower systolic blood pressure and heart rate, lower ratings of pain, anxiety, and fatigue, and more positive feelings and higher satisfaction about their rooms	Length of hospitalization, postoperative analgesics intake, vital signs (systolic and diastolic blood pressures, body temperature, heart rate, respiratory rates) Numerical rating scale: ratings of pain intensity, pain distress, anxiety and fatigue State-Trait Anxiety Inventory Form Y-1, Environmental Assessment Scale, Patient's Room Satisfaction Questionnaire	4 - 5 days
	Park & Mattson, 2009a	Randomized controlled trial	Patient room	- 90 adult patients after hemorrhoidectomy - 43 males and 47 females, mean age 47 years - randomly assigned	Foliage and flowering plants	Foliage and flowering plants vs. no plants	Experimental group showed following improvements: lower systolic blood pressure, and lower ratings of pain, anxiety, and fatigue	Length of hospitalization, postoperative analgesics intake, vital signs, ratings of pain intensity, distress, anxiety and fatigue, the State–Trait Anxiety Inventory Form Y-1, Environmental Assessment Scale, Patient's Room Satisfaction Questionnaire	3-5 days
	Park & Mattson, 2009b	Randomized controlled trial	Patient room	- 80 adult female patients after a thyroidectomy - mean age 36.2 years - randomly assigned	Foliage and flowering plants	Plants vs. no plants	Experimental group showed following improvements: shorter hospitalizations, fewer intakes of analgesics, lower ratings of pain, anxiety, and fatigue, and more positive feelings and higher satisfaction about their rooms	Length of hospitalization, postoperative analgesics intake, vital signs, ratings of pain intensity, distress, anxiety and fatigue, the State-Trait Anxiety Inventory Form Y-1, Environmental Assessment Scale, Patient's Room Satisfaction Questionnaire	6 days
	Khan et al., 2016	Randomized controlled trial	Two surgical wards	- 270 patients (experimental 135, control 135) - 20–50 years - randomly assigned	Foliage plants and flower	Foliage plants and flowers vs. no intervention	Experimental group showed shorter postoperative stays, lower intake of analgesics, lower pain intensity, less stress fatigue, improved vital signs (blood pressure, heart rate, respiration rate, body temperature)	- Vital signs: systolic and diastolic blood pressures (mm Hg), heart rate (beats per minute), respiratory rates (breaths per minute), and body temperature (0F). - Patients' Hospitalization Days - Analgesics Consumption - pain intensity, stress fatigue - questionnaire (not specified)	4-5 days
	Blaschke, O' Callaghan, & Schofield, 2017	Cross-sectional survey study	Waiting room, oncology outpatient clinic	- 143 adult participants (73 cancer patients, 13 staff, 52 carers, and 5 "others") - 24 - 89 years (mean 56)	Artificial plant arrangements, hanging installations, two movable green walls, and one rock garden on wheels	Artificial plant arrangements, hanging installations, two movable green walls, and one rock garden on wheels vs. no intervention	81% of respondents indicated "like/like a lot" when reporting their first reaction to the intervention. 48% were positively affected and 23% were very positively affected. 81% percent agreed/strongly agreed that "The greenery brightens the waiting room," 62% agreed/strongly agreed that they "prefer living plants," and 76% agreed/strongly agreed that "'lifelike' plants are better than no plants."	Observer ratings of perceived qualities and effects of artificial plants - purpose-built questionnaire	
	Emami, Amini, & Motalebi, 2018	Descriptive correlational study	Patient room	- 80 adult cancer patients (experimental 40, control 40) - age 18 - 85 - convenience sampling method	2 window outlooks: one with urban landscapes, another with natural scenery (hill with vegetation, trees)	Natural view through the window vs. no natural view	Experimental group viewing natural scenery showed less anxiety and pain than patients in control condition	State-Trait Anxiety Inventory, visual analog scale	3–7 days
	Koh, Rashid, Khaw, & Nasis, 2019	Randomized controlled trial	Patient room	- 122 patients with acute coronary syndrome (78 experimental; 57 control) - unknown age - randomly assigned	Flowering plants (Artificial potted roses from IKEA—a combination of colours)	Flowering plants (intervention) or no plants (control)	Experimental group showed lower mean depressive symptom scores. No significant changes in between-group anxiety symptom scores. Mean increase in anxiety symptom scores was not significantly different between groups.	Hospital Anxiety and Depression Scale, depressive and anxiety symptom scores	3–5 days
	Beukeboom, Langeveld, & Tanja-Dijkstra, 2012	Between-patients experimental design	2 hospital waiting rooms, Radiology Department	- 457 adults and children scheduled for echo, x-ray, MRI, CT patients (60% female and 40% male) - 14 to 88 years (mean 53.2) - randomly assigned	Real or artificial nature (Zamioculcas, Spathacea)	Real plants vs. posters of plants vs. no nature (control)	Experimental groups showed significantly lower levels of experienced stress , no difference for stres. Experimental conditions were rated as significantly more attractive.	Attractiveness of the waiting room on a 10-item bipolar adjective scale (5-point scales), Profile of Mood States, Dutch Short State Trait Anxiety Inventory (STAI)	~ 10 - 30 minutes

	Author	Study design	Setting	Participants	Intervention	Comparisons	Outcomes/Results	Methods	Duration
II. Visual representation of nature	Beukeboom, Langeveld, & Tanja-Dijkstra, 2012	Between-patients experimental design	2 hospital waiting rooms, Radiology Department	- 457 adults and children scheduled for echo, x-ray, MRI, CT patients (60% female and 40% male) - 14 to 88 years (mean 53.2) - randomly assigned	Real or artificial nature (Zamioculcas, Spathacea)	Real plants vs. posters of plants vs. no nature (control)	Experimental groups showed significantly lower levels of experienced stress , no difference for stres. Experimental conditions were rated as significantly more attractive.	Attractiveness of the waiting room on a 10-item bipolar adjective scale (5-point scales), Profile of Mood States, Dutch Short State Trait Anxiety Inventory (STAI)	~ 10 - 30 minutes
	Tse, Ng, Chung, & Wong, 2002	Randomized, controlled, cross-over study	Laboratory, tourniquet inflation	- 46 adults - 32 females, 14 males - mean age 21.7 years - age 19 to 27 - randomly assigned	videotapes showing natural environment, mountains and waterfalls during tourniquet inflation	videotapes with nature vs. no intervention	Experimental groups showed significantly better pain tolerance. The results indicated a significant increase in pain threshold and pain tolerance.	Self-report: report sensory experience 1-6 rating scale	10 minutes
	Vincent, Battisto, & Grimes, 2010	Mixed methods experiment between-group design	Simulated Hospital Patient Room	- 109 healthy college students - 56 females and 53 males - mean age 21.50 - randomly assigned	Images of nature: prospect (countryside), refuge (forest and trees), hazard (forest and trees), mixed prospect-refuge (countryside, forest and trees)	views of nature image: prospect, refuge, hazard, mixed vs. no nature image	Patients in the mixed prospect and refuge group had significantly lower perveived pain. Participants in the hazard image group had significantly lower diastolic blood pressure, but also high total mood disturbance.	The Short-Form McGill Pain Questionnaire, Profile of Mood States survey, systolic and diastolic blood pressure, heart rate, mean arterial pressure	60 minutes
	Nanda et al., 2012	Pre-interven-tion/ post-intervention research design	2 emergency departament waiting rooms	120 observations of children (30 before the intervention and 30 after the intervention in each waiting room) - unknown age	Combination of still and video art (flowers, landscapes, waterscapes), garden scene with window-within-a window effect	Art Intervention vs. no intervention	Experimental groups showed significant reduction in restlessness, noise level, and people staring at other people in the room. One of two experimental groups showed a significant decrease in the number of queries made at the front desk, and a significant increase in social interaction.	Systematic behavioral observation of patients and visitors (frequency counts, behavior maps, noise measurements)	65 minutes
	Aburas, Pati, Casanova, & Adams, 2017	Randomized controlled trial	Labor and delivery rooms	- 60 adult women in labor (experimental 24, control 26) - randomly assigned	Loop of 59 images of nature on a mobile TV cart (trees, flowers, water)	Intervention vs. no intervention	Experimental groups showed lower heart rates, higher Apgar scores, and higher Quality of Care From the Patient's Perspective (QPP). However, only Apgar scores were statistically significant.	Quality of Care From the Patient's Perspective (QPP) questionnaire, labor duration, vital signs (heart rate and blood pressure), pain (frequency of administration of pain medications), Apgar score	10 hours
	Pearson et al., 2019	Retrospec-tive study	Patient room	- 90 children patients - 2 - 18 years (mean 10) - randomly assigned	Three room conditions: aquatic window mural, tree window mural, or control condition	Intervention vs. no intervention	Experimental groups showed improvements in heart rate and systolic blood pressure. Results suggest that subject matter played a role, as patients in tree murals rooms had the most beneficial outcomes.	Data extracted from archival hospital records	2 days
III. Music and Sound	Kristjansdottir & Kristjansdottir, 2011	Randomized three-group experimental desing	Vaccination room	- 118 adolescents (headphones 38; ambient music 41; control 39) - aged 13–15 - andomly assigned	Musical distraction (top 10 charts of the day, one relaxing classical CD)	Musical distraction with headphones/without headphones vs. standard care control	Participants in the experimental group were less likely to report pain. Eliminating headphone emerged as a significant predictor of no pain.	Visual Analog Scale for pain	~ 10 minutes
	Caprilli, Anastasi, Grotto, Abeti, & Messeri, 2007	Randomized Controlled Prospective Study	Blood test room in hospital	- 108 unpremedicated children (experimental 54; control 54) - 4 –13 years of age, mean age 4.8	Live music	Live music vs. no live music	Experimental groups had significantly lower distress and pain intensity	Amended Form of the Observation Scale of Behavioral Distress, observation of behaviors, FACES scale (Wong Baker Scale) for pain	20 minutes
	Hartling et al., 2013	2-arm parallel randomized clinical trial with blinded assessment of the primary outcome	Pediatric emergency department	- 42 children (experimental 21; control 21) - aged 3 to 11 years, mean age 6 years - randomly assigned	Music recordings (The Planets Op. 32 Jupiter, Storms in Africa, Disco Beat, and Sunny Days)	Music vs. no music	No significant difference in the change in behavioral distress from before the procedure to immediately after the procedure. When children who had no distress during the procedure were removed from the analysis, there was a significantly less increase in distress for the music group. Pain scores among children in the standard care group increased by 2 points, while they remained the same in the music group, the difference was considered clinically important.	Observational Scale of Behavioral Distress–Revised Faces Pain Scale–Revised (0-10), heart rate	15 minutes

Author	Study design	Setting	Participants	Intervention	Comparisons	Outcomes/Results	Methods	Duration
Reychler et al., 2015	Randomized crossover controlled study	pulmonary rehabilitation room	- 41 adults with chronic obstructive pulmonary disease (experimental 21, control 20) - mean age 70.5 - 38 men, 3 women - randomly assigned	mix of music pieces at the same tempo	ambient music vs. no music	Perceived exertion was not modified by ambient music, but anxiety was improved. Dyspnea, fatigue and cardiorespiratory parameters were not influenced by music.	Perceived exertion (Borg scales), anxiety (Hospital Anxiety and Depression Scale-Anxiety Subscale), dyspnea (visual analog scale), cardiorespiratory parameters (heart rate monitor), level of satisfaction - 10- point Likert scale.	1h 15 minutes
Weeks & Nilsson, 2011	Prospective, randomized, controlled trial	Cardiac catheteriza-tion laboratory (cath lab)	- 98 adults (patient focused music music 34, loudspeaker music 30, control 34) - mean age 67 - randomly assigned	3 groups: patient focused music (audio pillow, MusiCure), loudspeaker music (MusiCure), no intervention	1. patient focused music (audio pillow, MusiCure) vs. no intervention; 2. loudspeaker music (MusiCure) vs. no intervention	Experimental groups showed lower anxiety score. No significant difference was measured between the anxiety score between the two music groups. Two experimental groups showed significantly more positive well-being.	- Anxiety - numeric rating scale (NRS) - Well-being and sound environment - 5-point Likert Scale questionnaire	30 minutes - 2 hours
Nilsson, 2009a	Randomized clinical trial	Recovery room, cardiothoraci c hospital unit	- 58 adults after coronary artery bypass grafting or aortic valve replacement surgery (experimental 28, control 30) - randomly assigned - mean age 64 years	Soft and relaxing music distributed through a music pillow	Music vs. no music	Experimental groups had a lower level of s-cortisol, however, this difference 30 minutes later. There was no difference in heart rate, respiratory rate, mean arterial pressure, arterial oxygen tension, arterial oxygen saturation, and subjective pain and anxiety levels between the groups.	Serum cortisol,heart rate, respiratory rate, mean arterial pressure - monitor arterial oxygen tension, arterial oxygen saturation - blood sample subjective pain and anxiety levels - numeric rating scale	30 minutes
Nilsson, Kokinsky, Nilsson, Sidenvall, & Enskär, 2009	Randomized between-group comparisons	postopera-tive care unit (PACU)	- 80 children (experimental 40, control 40) - age 7–16 - randomly assigned	MusiCure® soft and relaxing music	Music vs. no music	Fewer children in the experimental group received morphine. Experimental group showed a significantly higher individual decrease in the distress scores.	Numbers of participants who required analgesics, individual doses, objective pain scores (Face, Legs, Activity, Cry, Consolability, vital signs (Respiratory rate, heart rate, and saturation), administration of anti-emetics Self-reported pain (Coloured Analogue Scale), distress (Facial Affective Scale), anxiety (short State-Trait Anxiety Inventory)	45 minutes
Luis, Doss, Zayed, & Yacoub, 2019	Open-label randomized controlled trial	Operating room, hospital	- 12 adults for cardiac operations (experimental 6, control 6) - randomly assigned	Improvised and personally customized live oud music	Live oud music vs. no music (Oud is a traditional Egyptian instrument)	Experimental group showed statistically significant reduction in pain scores and respiratory rates and borderline significant reduction in heart rates, anxiety scores and serum cortisol levels.	Hamilton Anxiety assessment scale, vital signs: systolic and diastolic blood pressure, heart rate, respiratory rate, oxygen saturation, serum levels of cortisol, pain scores (Visual Analogue Scale)	20 minutes
Nilsson, 2009b	Randomized controlled trial	Recovery room	- 40 adults (music listening during bed rest 20, bed rest only 20) - mean age 64 years	Music listening during bed rest (MusiCure® soft and relaxing music)	Music listening during bed rest vs. bed rest only	Experimental group showed significant increase in the levels of oxytocin, subjective relaxation, and PaO2 levels. There was no difference in mean arterial blood pressure, heart rate and SaO2 between the groups.	Plasma oxytocin, heart rate, mean arterial blood pressure, oxygen saturation: blood gas (PaO2, SaO2) and subjective relaxation levels (numeric rating scale)	
Ovayolu et al., 2006	Prospective randomized controlled trial	Colonoscopy room	- 60 adults (music group 30, control 30) - older than 20 years old - randomly assigned	Traditional Turkish classical music	Listening to Turkish classical music vs. no intervention	Experimental group showed decrease in analgesics intake (no statistical significance difference), lower anxiety level, lower pain score, and higher satisfaction score	State-Trait Anxiety Inventory, patients' satisfaction, pain, self-assessed willingness to undergo a repeated procedure using a visual analog scale (VAS), sedative and analgesics intake	30 minutes
Camara, Ruszkowski, & Worak, 2008	Retrospec-tive case series	Ophthalmic surgery operating room	- 203 adults (115 experimental, 88 control) - mean age 64 ± 15	Live classical piano music	Exposure to live piano music vs. no music	Experimental group showed a statistically significant decrease in mean arterial blood pressure, heart rate, and respiratory rate in the operating room compared with their vital signs measured in the preoperative holding area. The control group showed a statistically significant increase in mean arterial blood pressure, heart rate, and respiratory rate.	Vital signs: Blood pressure (Mean arterial pressure), heart rate, and respiratory rate	1 - 3 hours

	Author	Study design	Setting	Participants	Intervention	Comparisons	Outcomes/Results	Methods	Duration
	Nikolajsen, Lyndgaard, Schriver, & Moller, 2009	Randomized between-group comparisons	Post-anesthesia care unit (PACU)	- 55 adults scheduled for anterior cruciate ligament reconstruction (MuViCure 19; MusiCure 18; control 18) - mean age 32 - randomly assigned	Audio stimulation (MusiCure) - music and nature sounds, audiovisual stimulation (MuViCure)	Audio stimulation (MusiCure) vs. no stimulation	The median intensity of pain during the procedure was significantly higher in the MuViCure group versus MusiCure and control. The median intensity of discomfort was also higher in the MuViCure group versus MusiCure and control. There was no difference between the three groups with regards to anxiety. 14 patients in the MuViCure group (74%) and 13 patients in the MusiCure group (72%) reported anonymously that the stimulation had a positive effect on their well-being during the procedure.	Self-assessed pain and discomfort on the numeric rating scale, State-Trait Anxiety Inventory (S-STAI), qualitative interview	30 minutes
V. Light	Rahimi, Makarem, & Rooyan, 2013	Randomized controlled trial	Operating room	120 adults (control 30, colorless 30, blue 30, red 30)	Flashlight intervention. Three experimental groups: 1) organic glasses with transparent (colorless) glass, 2) organic glasses with red glass, and 3) organic glasses with blue glass.	White camera flash vs. red camera flash vs. blue camera flash vs. no flash	The "blue group" had the lowest pain scores, followed by the red group, then the white group, all lower than the control group. The same pattern emerged regarding frequency of pain.	Pain: Visual Analog Scale (VAS), Verbal Rating Scale (VRS), and FACES Pain Scale (FPS)	
	Bakan, 2017	Experimental Study with Control Group	Blood collection unit	- 144 children (control 36, colorless 36, blue 36, red 36)	Flashlight intervention. Three experimental groups: 1) organic glasses with transparent (colorless) glass, 2) organic glasses with red glass, and 3) organic glasses with blue glass.	White camera flash vs. red camera flash vs. blue camera flash vs. no flash	Control group showed higher perceived pain (significant) and cortisol levels (insignificant) than the three experimental groups.	Wong–Baker FACES Pain Rating Scale, the visual analogue scale for pain, Cortisol level	~ 10 - 15 minutes
VI. Illuminated projection	Carwile, Feldman, & Johnson, 2014	Nonrando-mized intervention design	Colposcopy examination room	321 women (experimental 153; control 168) - mean age 30.3 - nonrandomized	Images on a light diffuser installed within ceiling light	Ceiling-mounted image vs. no ceiling-mounted image	Women in both groups reported high levels of preoperative anxiety. Experimental group showed 54% reduction in the odds of experiencing a given level of postexami- nation pain, holding preprocedure pain constant.	Self-reported pain - visual analog scale, Spielberger State-Trait Anxiety Inventory	10 - 20 minutes
	Quan et al., 2016	Randomized controlled trial	Radiography rooms	- 182 children (control 64; light only 54; animation + light 62) - 4–18 years old - randomly assigned	1. colorful lighting distraction only; 2.both colorful lighting and wall projection of child-friendly theme animations	1. colorful ambient lighting vs. no distraction, 2. both colorful lighting and wall projection vs. no distraction	Experimental group showed less low-stress coping behaviors and more verbal behaviors indicating positive affect.	Behavioral stress responses adapted from the Children's Behavior Coding System based on the Observational Scale of Behavioral Distress, self-reported happiness, visual analog scale for anxiety	2 minutes
	Zijlstra, Hagedoorn, Krijnen, van der Schans, & Mobach, 2017	Quasi-randomized experiment, between-subjects design	Computed tomography (CT) imaging rooms	- 97 adolescents (experimental 48, control 49) - quasi-randomized assignement - mean age 55 years	Use of motion nature projection in computed tomography (CT) imaging rooms - landscape	Motion nature projection vs. no projection	Experimental group showed no difference in perceived anxiety, however, rated the pleasantness of the room significantly higher. Experimental group had significantly decreased heart rate and diastolic blood pressure.	Short State-Trait Anxiety Inventory, pleasantness of the imaging room on a 10-point bipolar scale, heart rate and blood pressure	30 minutes
	Bonett, 2015	Experimen-tal survey study design	Computed tomography (CT) and radiation therapy rooms	- 41 radiography patients - 31–76 years, mean 57.9 years - nonrandomized	Ceiling art (day: blue skies with surrounding trees / night theme: sky with external environment)	Theme day vs. theme night	89.8% of patients from the experimental condition reported a positive reaction to the intervention. We can infer that ceiling artwork positively influenced patients' experiences during radiation therapy treatment. Patients did not show an overall preference for either theme.	Patient's experience - 12-question survey (emphasis on aesthetic appeal, patient treatment experience and the patient's engagement due to the ceiling display)	~ 30 minutes
	Pati et al., 2016	Between-subject experimental design	Patient room	- 181 adults (experimental 100; control 81) - similar demographics - mean age 57 - randomly assigned	4 feet wide and 6 feet long ceiling mounted photographic sky compositions	Ceiling-mounted image vs. no intervention	Experimental group showed significant positive outcomes in environmental satisfaction and diastolic blood pressure (BP). Environmental satisfaction in the experimental group was 12.4% higher than the control group.	Length of hospital stay, systolic and diastolic BP, Stress/Arousal Adjective Checklist, State-Trait Anxiety Inventory for Adults, sleep quality, pain medication and indigestion medication intake, investigator-designed questionnaire	~ 4 days

	Author	Study design	Setting	Participants	Intervention	Comparisons	Outcomes/Results	Methods	Duration
VII. Audiovisual	Pati & Nanda, 2011	Quasi-experimental design	2 Waiting areas: dental clinic and cardiac clinic	- 81 pediatric patients dental clinic, 77 cardiac clinic) - 5-17 years old - complete demographics not available (observation)	(1) The nature image static slide show, (2) dynamic Ambient Art, (3) dynamic Ambient Art with sound, (4) dynamic aquarium, and (5) dynamic aquarium with sound	5 distraction conditions on a single plasma screen vs. no distraction	Experimental group showed more calm behavior and less fine and gross movement, suggesting significant calming effects associated with the distraction conditions.	Observation/recording of behavior	10 minutes
	Diette, Lechtzin, Haponik, Devrotes, & Rubin, 2003	Randomized controlled trial	Flexible bronchos-copy room	- 80 adults (experimental 41, control 39) - mean age 55 - partial randomization (patients from one day assigned to experimental condition or control condition)	Nature scenes murals placed at the bedside, tape of nature sounds (mountains, water, greenery) on headphones	Intervention vs. no intervention	Experimental group showed significant decrease of reported pain. No difference between the groups for anxiety.	- Self-repoted pain control (a 5-point scale ranging from poor to excellent) - Anxiety (S-STAI)	30 - 60 minutes
	Lechtzin et al., 2010	Randomized controlled trial	Bone marrow aspiration and biopsy procedure room	- 120 adults with cancer (44 Nature group, 39 City, 37 control) - randomly assigned	Nature scene with accompanying nature sounds (mural of a mountain stream in a spring meadow) or city scene (urban scene with buildings and cars) with city sounds	Intervention vs. no intervention	No significant difference for pain scores between the three groups.	Visual analog scale of pain; patient's satisfaction (5-point Likert-type scale), psychologic distress (Brief Symptom Index); negative mood states and anxiety (Profile of Mood States), heart rate, blood pressure, and salivary cortisol levels	
	Nielsen, Wåhlin, & Frisman, 2018	Three-arm, randomized intervention study	Operating room, hospital	- 174 adult patients (58 pictures; 72 music, 44 control) - randomly assigned	Viewing pictures of natural scenery on an iPad or listening to soft instrumental music (MusiCure)	Viewing pictures of natural scenery on an iPad vs. listening to soft instrumental music (MusiCure) vs. no intervention	No differences related to anxiety after surgery were found among the three groups. Younger patients had a higher degree of anxiety and lower degree of postoperative relaxation and well-being.	State Trait Anxiety Inventory short form; visual analogue scale - anxiety, well-being, relaxation, and pain	
	Nikolajsen et al., 2009	Randomized between-group comparisons	Post-anesthesia care unit (PACU)	- 55 adults scheduled for anterior cruciate ligament reconstruction (MuViCure 19; MusiCure 18; control 18) - mean age 32 - randomly assigned	Audio stimulation (MusiCure) - music and nature sounds, audiovisual stimulation (MuViCure)	Audio stimulation (MusiCure) vs. no stimulation	The median intensity of pain during the procedure was significantly higher in the MuViCure group versus MusiCure and control. The median intensity of discomfort was also higher in the MuViCure group versus MusiCure and control. There was no difference between the three groups with regards to anxiety. 14 patients in the MuViCure group (74%) and 13 patients in the MusiCure group (72%) reported anonymously that the stimulation had a positive effect on their well-being during the procedure.	Self-assessed pain and discomfort on the numeric rating scale, State-Trait Anxiety Inventory, qualitative interview	30 minutes
	Watts, Khan, & Pheasant, 2016	Experimen-tal survey study design	Waiting room in a student health center	- 81 participants in each condition - Pairs of participants matched based on age and gender - average age ~ 25 years	Natural sounds (water sounds) and large images of natural landscapes (coastal views), and fresh flowers (potted Chrysanthemums)	Natural sounds and large images of natural landscapes, and fresh flowers vs. no intervention	Experimental group showed improvements in perceived tranquility, however no significant reductions for anxiety.	Self-reported levels of anxiety and tranquillity	

	Author	Study design	Setting	Participants	Intervention	Comparisons	Outcomes/Results	Methods	Duration
VIII. Audiovisual with light	Klaming, Van der Zwaag, Van Minde, & Geraedts, 2013	Quasi-experimental design	X-ray room	- 149 participants (control 43, AVI 37, AVI + info 33, AVI + info + choice 36) - mean age 54.6 years - partial randomization (patients from one day assigned to experimental condition or control condition)	Audiovisual intervention developed by Philips Healthcare (combination of dynamic colored ambient lighting, video projections of nature imagery, and sound)	(1) No intervention vs. (2) audiovisual intervention vs. (3) audiovisual+ patients received information about it vs. (4) audiovisual intervention, information about it, and choice of the audiovisual theme	Initial anxiety levels were low. No significant difference for anxiety level. Patients were most likely to recommend the hospital when they received the audiovisual intervention and information about it.	- State anxiety - State-Trait Anxiety Inventory - Need for control - Krantz Health Opinion Survey (KHOS), - Active coping - Utrecht Coping List (UCL) - Satisfaction with the hospital - Net Promoter Score (NPS) using 11-point Likert scale	
	Vogel et al., 2012	2-stage study randomized clinical trial	PET uptake room	- 101 patients (experimental 51 patients, control 50) - randomly assigne - mean age 59	Audiovisual imagery: TV above the patient bed (video with nature scenes), colored lighting in the rims around the installation; audio was ambient electronic music (Light: static monochrome color or a color that dynamically adapted itself to the colors presented on the television screen)	Audiovisual imagery vs. no intervention	Throughout the stay in the uptake room, a significant decrease in overall anxiety was found, together with several other significant changes in patient physiology. In the cohort with audiovisual intervention, however, the decrease in patient anxiety was significantly larger. The cohort with intervention also showed significantly lower 18F-FDG uptake in brown adipose tissue BAT but not in muscles.	Physiologic measurements: Salivary cortisol concentration, heart rate, heart rate variability, muscle activity, skin conductance level, uptake in muscles; uptake in brown adipose tissue State-Trait Anxiety Inventory questionnaire and the F-FDG uptake evaluation	
	Gómez-Urquiza et al., 2016	Randomized controlled clinical trial	Waiting room before surgery	- 180 adults for tolaryngology surgery (intervention 1 - 60, intervention 2 - 60, control - 60) - 25–50 years	Photographic display with music (projection of video with photographs: landscapes of the province and views of the city of Granada; relaxing music)	1. Photographic display vs. no intervention; 2. photographic display with music vs. no intervention	Experimental group (photographic display) showed lower means for all variables, but only the result for respiratory rate was statistically significant. Experimental group (photographic display and music) showed statistically significant results for all measured outcomes except diastolic blood pressure.	State anxiety - State-Trait Anxiety Inventory, heart and respiratory rate and blood pressure	22 minutes

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